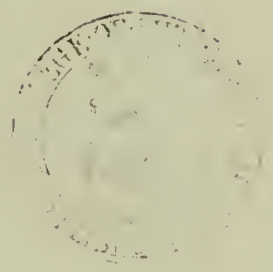
ON

HEATING, AËRIFICATION,

AND

VENTILATION.



BY

JULES NOIRSAIN,

CIVIL ENGINEER.

TO

HIS ROYAL HIGHNESS PRINCE ALBERT,

&c., &c.

SIR,

A CONTRIBUTOR myself to the Exposition originated by the genius of your Royal Highness, and which will for ever distinguish the year 1851 in the Scientific Annals of the World—I have respectfully ventured to dedicate to your Royal Highness my Brochure on HEATING, AËRIFICATION, and VENTILATION; feeling satisfied that an endeavour having for its object the increase of comfort, and promotion of health—will not be deemed foreign to your Royal Highness's consideration.

With every sincere wish that your Royal Highness may live long to witness the fruits of the Scientific Congress of All Nations,

I beg to subscribe myself, Sir,

Your Royal Highness's obedient humble Servant,

JULES NOIRSAIN.

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Fig. 4.

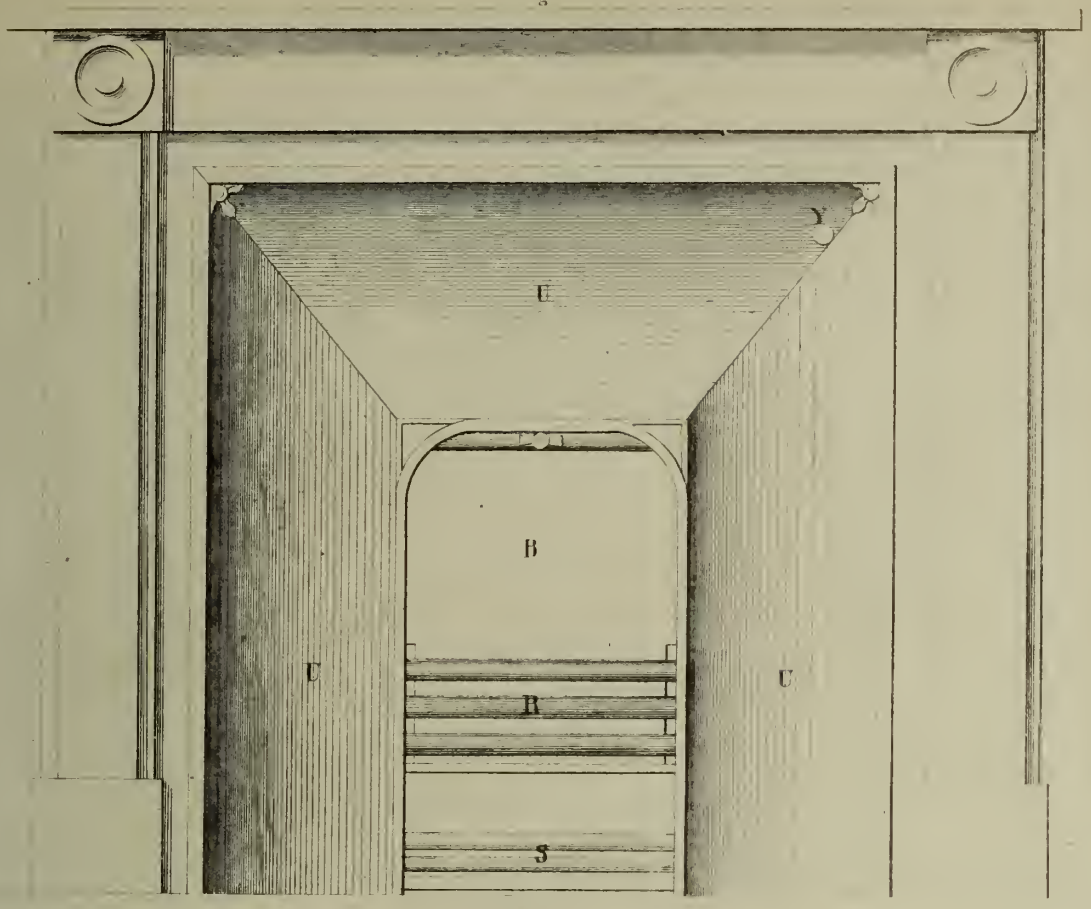


Fig. 3

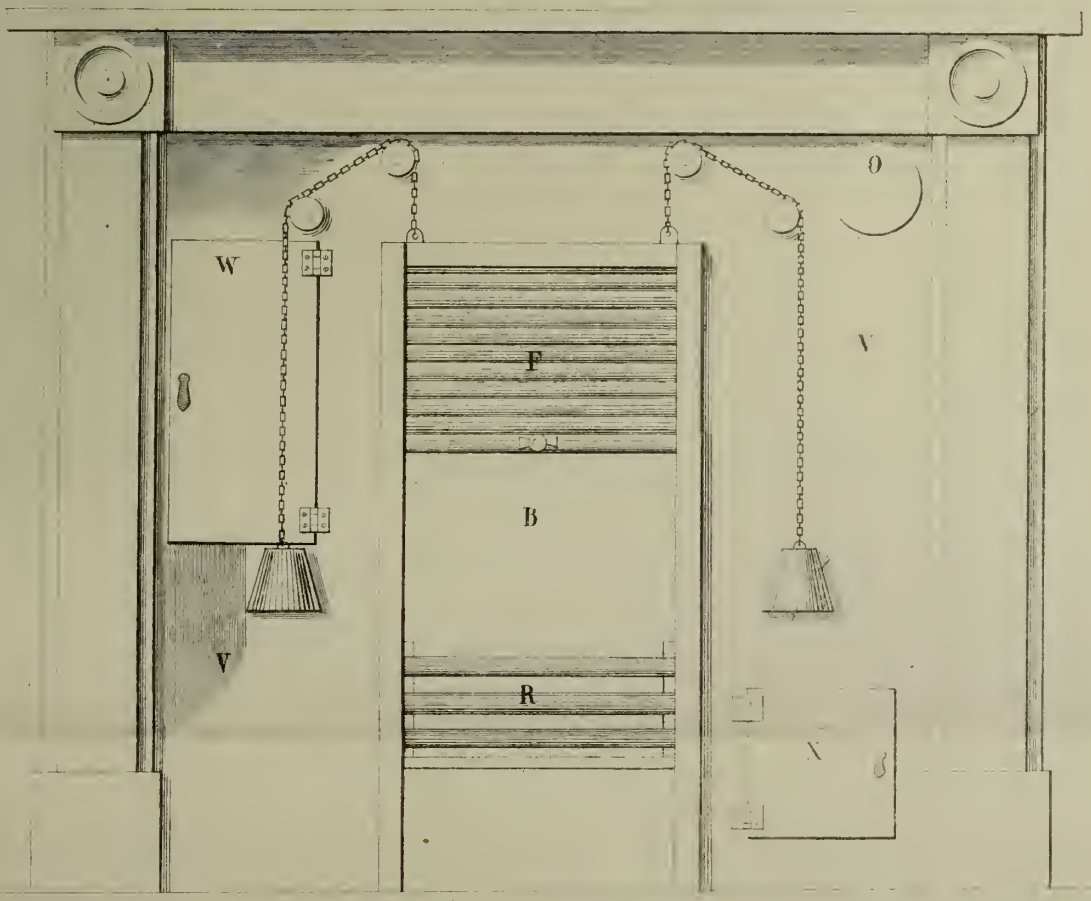


Fig. 1

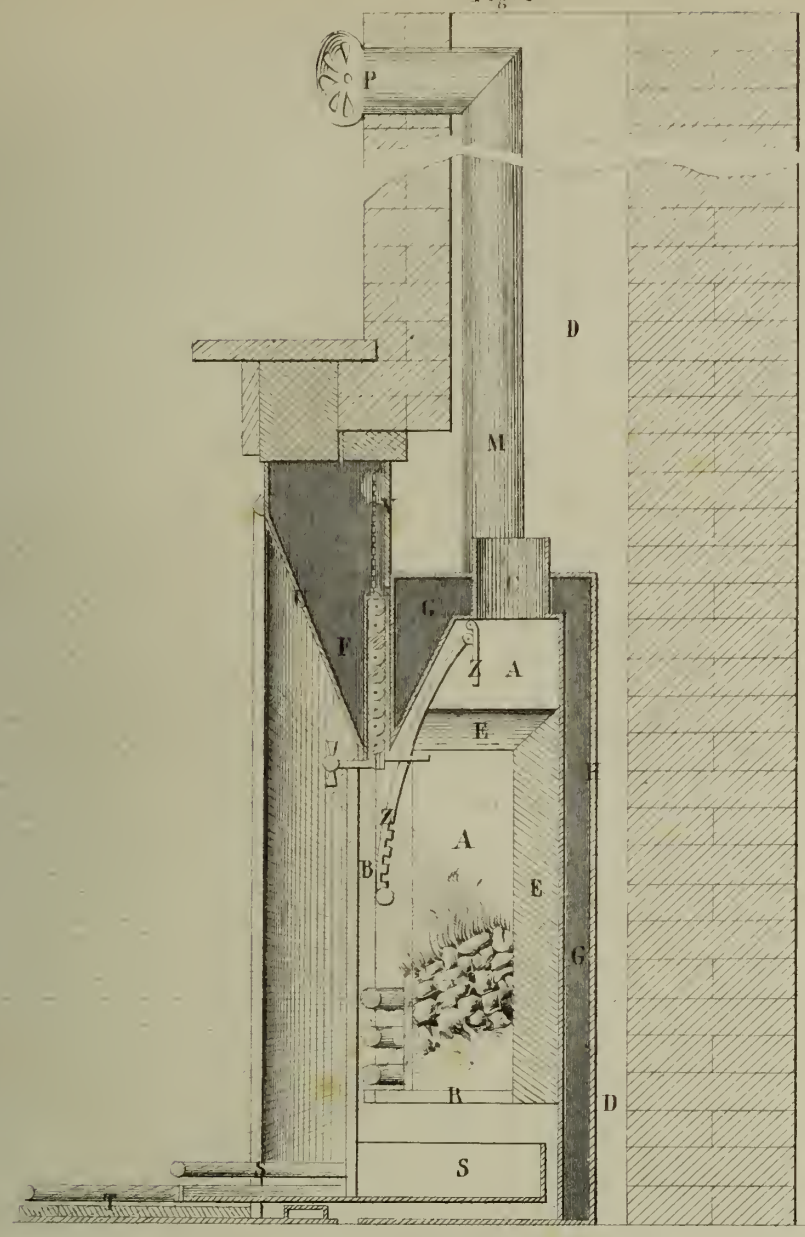
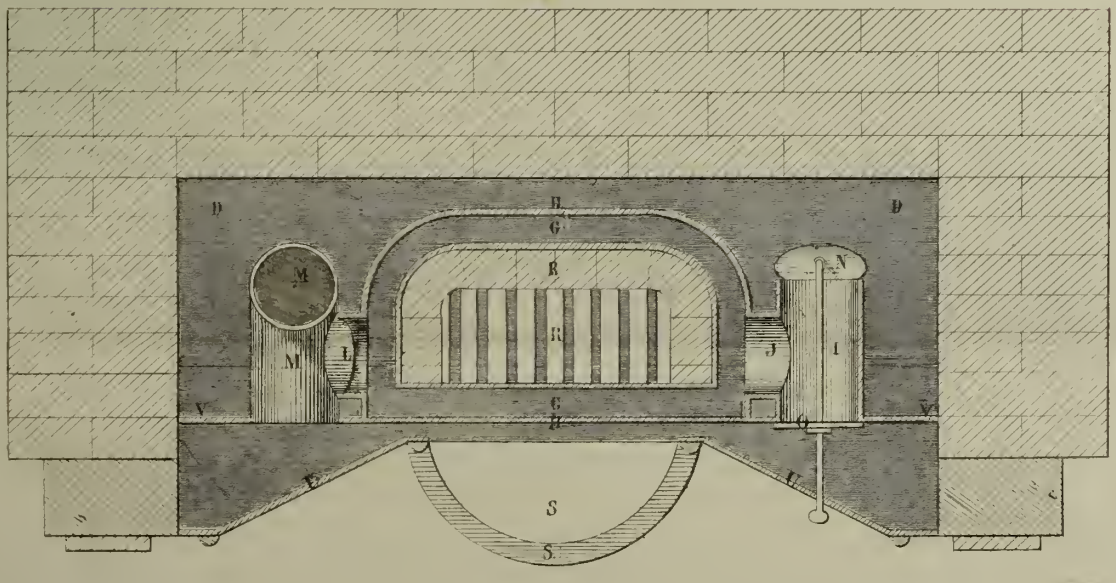


Fig. 2



ON

HEATING, AËRIFICATION, AND VENTILATION.

Preliminary to the development of this subject, it will be requisite that I define the meaning of the words *aërification* and ventilation — words which are necessary to the complete exposition of the subject under consideration, although the latter has been hitherto exclusively employed by English authors.

Scarcely less important than alimentation to the sustenance of animals, is the maintenance of a due supply of pure unvitiated air; yet few subjects of equal importance have been so greatly neglected, not only by society in general, but by the practical chemist, the builder, the engineer.

If an animal be confined in a given volume of atmospheric air — a volume which is neither capable of exchange nor purification — the animal dies; hence a system of exchange of *vitiated* for *non-vitiated* air is a necessity indicated by evidence the most pointed and undeniable; yet we shall find that in the greater number of instances, the means of effecting this exchange are not supplied scientifically by the foresight of man, but by the operation of certain natural causes, and often in spite of man's endeavours of a directly opposite tendency.

A certain indefinite, and within given limits uncontrollable, circulation of air therefore must exist in every department which is tenanted by living beings; this aërification, the means of causing it, of regulating it at will, of modifying it to suit the different conditions of breathing animals, it is my object in this paper to describe.

By the term *aërification*, then, I wish to designate the simultaneous efflux and afflux of air into and from an apartment: by the term ventilation, the motion of air within the apartment itself, determined by the effects of heat or any other motive force. Now, although the displacement of air of which I have spoken may be made to ensue without any employment of calorific means, yet in the great majority of cases, the aërification and ventilation of an apartment are largely, if not altogether, dependent in the due application of heat; and therefore we are led at once to discuss in connection with these subjects the nature of fireplaces of different kinds.

In the application of the calorific principles which determine and regulate the due supply of air, a slight amount of reflection will demonstrate that a very imperfect and incomplete co-operation has hitherto subsisted between the various parties concerned. The stove or grate manufacturer does not concern himself to act in concert with the builder; the builder, in constructing his house, too frequently neglects all communion with the practical chemist and engineer; chimneys are constructed without reference to the size of apartments:—saloon or bedroom, closets or spacious halls, whether capable of holding several hundred individuals or only nine or ten, the area of the chimney is usually the same; and then, to complete the violation of every principle which the proper supply of air demands, doors and windows are built in with every crevice so closed up that the air necessary for respiration only finds entrance by key-holes, chinks, and crevices, which the artificer has not been able entirely to occlude. The result is easy to anticipate: the balance between the *afflux* and *efflux* of air is disturbed, aërification is impeded, the chimney smokes; and those who are unfortunate enough to be in such an apartment suffer from all the disagreeable symptoms of insufficient and vitiated airs.

The architect makes no provision for the entrance or *afflux* of pure air; on the contrary, he shuts it out to the best of his ability, and it only rushes in irregularly, and, so to speak, by stealth. As regards the air's exit or *efflux*, the English architect indeed makes competent pro-

vision, not however with any object of effecting aërification, but in virtue of an act of Parliament made with the view of protecting the chimney sweeper. By the provisions of this act, it is stipulated that every chimney shall at least present a section of nine inches by fourteen. This provision, not of much use as regards the community of sweeps (seeing that machinery for chimney cleansing is now almost invariably employed), has, however, been productive in Britain of great hygienic advantages: in Belgium, however, where no such law exists, the chimneys of modern date generally present a diameter of no more than four, five, six, or seven inches at the most, thus presenting an area merely sufficient to carry off the smoke of a closed stove. In an arrangement of this kind the power of aërification is so slight as to be scarcely worthy of notice.

Thus the manufacturer on his part constructs a stove without reference to its special use; taking no cognizance of the size of the chimney with which it is to be connected, paying no regard to the alteration of the air upon the red hot surface of the iron of the stove or grate, leaving unnoticed the important subjects of *afflux* and *efflux* of air, condensation of smoke, and, in fine, every function collateral to the mere production of heat. Hence, as a frequent result, the fireplace smokes, distributes an insufficient amount of heat, decomposes and vitiates the surrounding air, produces a suffocating heat, disengages an excessive volume of smoke, or deposits large quantities of soot.

In England, the great centres of population offer striking and most painful examples of smoke condensation, and deposit of soot.

In Belgium, France, Germany, and Russia, we are presented with an almost invariable want of sufficient aërification, and a noxious decomposition of the atmosphere; both exceedingly detrimental to the animal economy.

In England, the engineering chemist, who has succeeded, after years of application and under circumstances of great difficulty, in effecting a system of heating by means of a current of hot air, of which the afflux is determined by a special shaft in which the column of air is rarefied by fire — he is persuaded that this system of heating offers the best possible means of aërification. But, having regard to all the circumstances and necessities of the case, it may justly be doubted whether the foregoing opinions be correct. The engineer establishes, it is true, an afflux and efflux of air, but the afflux of air is *hot, dry, rarefied*, containing torrified particles of organic matter, and deprived, to a variable extent, of the moisture which is so necessary to the breathing economy of animals. Is it not demonstrable that aërification under this system of heating is an impossibility? Ventilation, indeed, exists; but there is no aërification, all entrance of cool, refreshing air being so adverse to this method of heating, that it is a necessity of the operation to fasten down even the window-sashes. The advocate of this plan, indeed, is so satisfied of the necessity of the presence of aqueous vapour, that he now supplies it by artificial means. But the vapour of boiling water is far different to the humidity ordinarily existing in the atmosphere, for which it cannot, with any degree of propriety, be substituted.

In another case the engineer, in order to effect aërification, not only by the inferior aperture of the chimney, but also at some distance up its elevation, establishes a lateral aperture in its side on a level with the flooring to be aërified.

From this arrangement two great inconveniences arise. In the first place every variation of atmospheric pressure causes the ascending smoke to be driven back into the apartment; and, in the second place, the lateral current of cold air thus admitted into the chimney, effects a condensation of smoke into soot, and thus, amongst other ill results, considerably augments the danger of fire. The first inconvenience is said to be remedied by the addition of a flap to the lateral aperture, which closes in the backward pressure of every downward atmospheric oscillation; but the second inconvenience (recognised by act of Parliament) has not hitherto been overcome.

As regards the curers of smoky chimneys, vulgarly called *smoke doctors*, they only have one means of attempting to effect their object, namely, by affixing to the chimney-top hoods and weathercocks of various shapes and kinds: of these examples, England, Belgium, Germany, and France, present more than enough, although Paris in this respect excels other places.

It is to be regretted that scientific writers have not digested into any system the various isolated facts made known by different persons concerning the subject of applying heat to apartments. Each has been allowed to make his own statement; but the co-operation so much to be desired between the architect, the grate manufacturer, the builder, and the engineer, remains to be effected.

Seeing the want of co-operation which exists amongst the different classes, on whom the responsibility of securing an improved aërificative distribution of heat and ventilation devolves; and seeing the vast importance of these subjects to the health of nations, it is not too much to hope that the Exposition of Hyde-park may stimulate some academy or some Government to take the subject under its consideration, and reduce it to one comprehensive whole.

Let us now proceed to investigate the different means at our disposal for the construction of a fireplace that shall enable us to heat, to aërify, to ventilate. There are four means at our disposal for effecting the distribution of heat:—Radiation from burning materials; emission of heat from a heated surface; radiation and emission of hot air simultaneously; and, lastly, the substitution of a heated current of air for one of the previous means.

The first we should employ as a permanent means of distributing heat; the second we may avail ourselves of as an additional power; the third we may reserve for application to certain special cases; and the fourth we should reject altogether, as inimical to the health of living beings; because, by following this plan, the afflux of cool and fresh air which should take place is deflected from its ordinary direction, the doors and windows, in order that it may pass into the apartment by a special canal—the air having been already heated, and consequently, as I have already shown, altered as to its character.

Such are the means at our disposal—such the principles which should guide us in our efforts: let us now see how they can be applied to practice.

By reference to figures 1 and 4 it will be observed that, by concentrating the calorific rays of the fire in a space of iron, A—open at B to admit of radiation, and at C for the disengagement of smoke; by apportioning the size of the opening, B, to the size of the section, D, of the chimney; by furnishing the opening, C, with a register, Z, which governs the disengagement of smoke and heat in the chimney; by walling up the space, A, with fire-bricks, E; by so calculating the size of the space between the upper part of the grate, R, and the upper part of the opening, B, that the cold current cannot introduce itself in the flue of the chimney marked D; by not permitting the grate, R, to project beyond the opening, B; and, lastly, by furnishing the opening, B, with draught-plate or flap, F, by the elevation or depression of which the intensity of combustion may be regulated, we obtain all the desiderata of good combustion, which may be thus recapitulated:—

1. Facility and economy of heating, without introduction into the apartment of smoke, ill odours, or injurious gases.

2. Imparting to the flue, D, of the chimney such a temperature that the smoke becomes incapable of condensation, and the formation of soot is thereby prevented: thus removing one of the greatest pests and inconveniences of thickly populated towns.

3. Increasing the intensity of the fire to such a degree that the greater part of the smoke becomes consumed;—indeed with certain kind of coals—for instance those of the central English coalfield for example, absolutely no smoke results. So much then for the calorific appliances of a good fireplace: let us now examine its relations to the subjects of *aërification* and ventilation.

The volume of admitted air, or in other words its *afflux*, ought to be in exact ratio to the amount of the volume expelled, or in other its *efflux;* hence there should be, for hygienic purposes, a continual change of air. Without complete *aërification*, mere high temperature is intolerable, or *asphyxiating;* hence, if the production of heat be necessary, so is *aërification* indispensable; seeing that not only living beings but candles, lamps, articles of furniture—nay, even the fireplace itself continually vitiate the atmosphere of an apartment, and render absolutely necessary an atmospheric change.

In fine, *aërification* has for its effects the pre-

vention of atmospheric stagnation,—prevention of the accumulation of injurious gases ; — the maintenance of a due afflux and efflux of air, but in currents so divided and genial that they shall not be felt ; that the warmth shall be equally distributed throughout the room. It is effected by means of establishing two atmospheric currents, one at the lower and one at the upper part of the chimney. Ventilation consists in causing the cold air of the lower part of the room itself to pass over the surface of the space, A, and to be disengaged hot, high up in the apartment. The air which is inspired and expired from the lungs—the flame of lamps and candles, indeed ascension of heat from any cause—the opening and shutting of doors, the movement of people in a room,—are all so many causes of ventilation.

With an apparatus embodying these principles, we may not only draw off the vitiated current of air which lingers near the ceiling of a room, but under certain circumstances, where mere radiation is an insufficient means of elevating a temperature to the desired pitch in a given time, we may distribute a heated current of air from above ; thus aiding the radiative distribution of the stove from below. To this operation the term ventilation may be applied.

This may be demonstrated by reference to the figures 1 and 2, and the effect of which I have spoken, naturally results from the consideration of aërial rarefaction as a creative force, susceptible of being regulated, modified, and subjected, to the principles of mechanical laws.

Referring to the accompanying figures, it will be seen that by encompassing the space, A, by a second space, H, a third chamber or space, marked G, results ; if we now adapt on the left hand side of the space, H, a flue, M, the orifice of which, L, communicates with the space, G, and the orifice, P, with the apartment at the length of D ; if we now adapt on the right of the same space, H, a second flue, I, having three orifices of which the former, J, communicates also with the space, G, the second, N, communicating with the flue of the chimney, D, and the third, O, communicating with the apartment through the slab of iron, V ; and finally, if we add valves to the orifices, N and O, constructed in such a manner that the action of throwing one open shuts the other, we accomplish the *aërification* and ventilation of an apartment with the greatest perfection.

Let us now suppose a fire to be placed in the space, A; that the air is rarefied in the space, G ; that the valve, N, is open ; under those circumstances the atmospheric pressure will exert itself on the space, G, along the flue, M, and the heated air will become emitted by the open aperture, N, into the flue, D, of the chimney. If, on the contrary, we suppose thus, the valve, N, is shut, and that the valve, O, is open—then under the latter circumstances the atmospheric pressure will exercise itself in the space, G, along the flue, I, and the heated air will become disengaged by the orifice, P, into the apartment.

Hence by means of these two valves it is evident we have the power of producing an ascending current of hot air, or a descending current of cold air, through one and the same flue, M.

S, is the ash-pan.

T, the fender.

U, a pannel opening like a door, and also serving as an ornament to the chimney.

V, an iron plate hermetically closing the opening of the chimney.

W, door for cleansing the chimney.

X, door for removing the soot.

That the principles just understood, and their application as indicated, afford one of the best means, if not the *very* best, of accomplishing *aërification* and ventilation there can be no doubt ; but further investigations will be necessary before the exact ratios of the areas of chimneys, and the areas of the apartments in which they are placed, can be precisely determined; as also the beast means of effecting the primary afflux of air into the hall and staircase of buildings, and thence into each chamber.

I cannot conclude this subject without recommending the application of two flaps to each flue ; one opening outwards and closing a door through which the chimney may be swept from above ; the other intended to lie transversely across the flue, and to stop all draught, if from any cause the chimney should take fire.

131, *Regent Street, Sept.* 25, 1851.